

the ToneQuest Report™

The Player's Guide to Ultimate Tone



Transformers 101

with Professor **Sam Bisbee**

Hey, you guitar players... don't think for a minute that you should skip the following articles because they are too technical. You've dropped some big money over the years on your guitars and amps, right? *Transformers* are the very heart of every amplifier, and your *output transformer* can influence your tone every bit as much as your choice of pickups, tubes, and speakers. Our attention was recently focused on *output transformers* after one of our all-time favorite "keeper" amps, a blackface Fender Pro Reverb with an amazing pair of Jensen Vibrato speakers went down with a bad *output transformer*. (By the way, Pro Reverbs remain some of the best vintage bargain tone machines every made, and why they have failed to receive the high praise and prices reserved for blackface Super and Deluxe Reverb amps is mystifying. Get yours now.) Cesar Diaz kindly sent us a new Mojo Tone replacement *OT*, and it was immediately apparent to us that although we had always considered the tone of our Pro to be extraordinarily good, things had improved significantly after installing the new *OT*.

The amp had more punch and power with less sag, and that got us wondering if *output transformers* could slowly decay over time, subtly sapping the full potential of a great amp. We concluded that it can, which led us to consult with a couple of experts on the topic of guitar amplifiers and *transformers*. We asked Victoria Amplifier founder Mark Baier (aka Sam Bisbee) to comment on his experiences with *OTs*, along with the premier builder of custom amplifier *transformers* on the planet, **Sergio Hamernik** of **Mercury Magnetics**. **Sergio** has been blueprinting exceptional vintage examples of the great *transformers* of the past and supplying discerning guitarists and their technicians with accurate reproductions that succeed in delivering authentic vintage tone. Stay tuned for reviews.



TQR: Good Morning Mr. Bisbee. Your mission, should you choose to accept it....

Yikes, I expected the computer to go up in a puff a smoke!

So you want to know the inner secrets of *output transformers*, eh? Be forewarned – once you make that commitment, you'll be cursing the days when you slept through "Advanced Frightening

Mathematics 300...." How's this for a wake up call? The following is the very first paragraph from Chapter V of the venerable RCA Radiotron Designer's Handbook (4th ed.).

TRANSFORMERS & IRON CORE INDUCTORS

(i) Definitions

An ideal transformer is a transformer in which the winding reactances are infinite, and in which winding resistances, core loss, leakage inductances and winding capacitances are all zero. In such a transformer the voltage ratio between any two windings is equal to the turns ratio of the windings under all conditions of loading. Also, in such a transformer the currents in any two windings are inversely proportional to the ratio of turns in the windings under all load conditions....

The entire chapter is 53 pages long!

To keep things from getting out of hand, let's just say that there are many factors influencing *output transformer* performance. Aside from an obvious fault like a shorted winding, fatigue of the core (the metal laminations) is the most prominent consideration in *transformer* output and tonality.

Fatigue is a natural consequence of normal operation. Suffice it to say that it's a veritable Fourth of July inside the atomic workings of your *output transformer* every time you bust your best licks through it. The magnetic properties of the metal used in the core, the type of laminate used, the size of the core, and many other factors contribute to the final performance and longevity of the *output tranny*. Actually, most guitar amplifier *transformers* are made of rather inexpensive materials (yeah, try telling that to your parts supplier).



The real high end stuff ends up in mega bucks hi-fi and industrial applications. In the grand scheme, guitar amps don't rate the kind of respect we tone geeks assign to them.

To understand why a *tranny* gets fatigued, let's remember what's happening in the *OT*. You are transforming a high voltage/

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The Tone Tubby

W... he said it more than before in these pages... Speakers are the final manufacturers in the chain that define your tone. With some care, consistency and a little bit of... can have reports on what may be the most significant developments in guitar speaker design to have occurred in decades, and it's based on an original "technology" that is over 2,000 years old.

John Harrison of A Brown Sound (see page 11) has had his own speakers in San Rafael, California for nearly 20 years, and his client list is a Who's Who of respected bands and musicians, including Carlos Santana, Pearl Jam, Metallica, WEA, Van Halen, Robert Cray, Bruce Mountain, Steve Kimock, Mark Knopfler, Ben Sigsbee, Steve Morse, Neil Young, and many more. Harrison has been refining his winding techniques and selection of superior speaker components for decades, and he has earned a reputation for building out a high order music in, according to...

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low current signal into a low voltage/high current signal. There are lots of electrons jumping around from point "A" to point "B." This creates magnetic relationships and phenomena that act to age (or fatigue) the characteristics of the iron. Over time, the constant forces acting on the core change the ability of the laminate material to perform its duty efficiently. It will



saturate quicker, and it reacts differently than when it was new, thereby altering the tone and performance of the amp.

To be sure, this is a slow, incremental change, and one which will take years of use to manifest as a perceivable degradation in tone. In fact,

one of the reasons we like old '50s amps is the quicker saturation and compression of an old, fatigued *tranny*, so don't get too spun out of shape thinking your tone is being sucked away by a tired *transformer*. It may be your personal ticket to tonal nirvana. Just remember, however, that old amps with old *trannys* means old everything else, too... yin and yang.

Most of us are looking for the most reactive, intuitive amp that our minds and fingers can handle. In many cases, if the amp is checking out A-OK but it's otherwise sounding a bit soft and saggy, perhaps a popping a new *transformer* in is just the ticket. Replacing an *output transformer* is not an inexpensive procedure, but it's a simple one, and one that is easily switched back if the results are less than fruitful. As to the question of swapping out old components like caps and resistors that test and sound good, I advise leaving the old ones in when we are dealing with vintage

pieces, the qualifier being that these components should test and sound good. Unless the '57 Bassman amp in question is going to be used on an extended 300 date tour to sold out sheds, leave it alone. Most vintage amps will let you know that they're giving it up by an audible degradation in tone and performance. Let's face it, a 40-year-old capacitor will most likely fail in the next couple of decades (especially filter caps), so consideration must be given to the intended application of the amp. For most weekend warriors, the original passive components will suite you fine if they test and sound good. One last thought on the use of increasingly expensive NOS tubes in an amp that is old.... You will have to determine if you want to jeopardize a \$259 pair Mullard EL34s in a vintage 40-year-old amplifier. When a coupling cap decides to fail, it can put the tube in a potentially dangerous operating point, causing it to fail too. I know I'm kinda swinging both ways here, but in this case, the vintage geek wins out (let's not forget the tales of unscrupulous techs carving all the old Astrons out of vintage amps and then turning around and selling them for big bucks – it does happen, folks).

I could go into a more, more, extra more technical explanation of what's happening in an *OT*, but I don't want to lose everybody in a run down of big math with variables like reactance, gilberts, and flux densities that would scare everybody into suicidal seclusion....

I remain,
Mark Baier, a.k.a. Sam Bisbee
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